AST New Generation Simulators for New Generation Aircraft

Link
A DIVISION OF THE SINGER COMPANY

ADVANCED SIMULATION TECHNOLOGY

Advanced Simulation Technology *(AST*)* was developed to provide a new generation of *Link** flight simulators to meet training requirements for a new generation of aircraft.

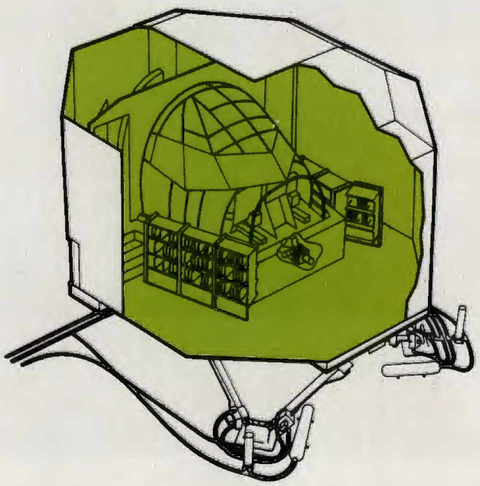
This was accomplished by redesigning simulators "from the ground up," introducing new concepts and techniques which have advanced the state-of-the-art in the quest for 100% simulation.

This total redesign effort has produced significant improvements in performance, reliability, maintainability and life cycle costs.

*AST** simulators are the culmination of a far-reaching research and development program begun in early 1973.

Three years of intensive work produced improvements in every major element of simulator design. Traditional design concepts were abandoned in favor of the many practical benefits that modern electronic packaging techniques can provide. The result is the most significant advancement in the simulation industry since development of digital devices in the 1960's.

A number of airlines and non-commercial customers already have availed themselves of the many advantages afforded by *AST*—the simulators of the 1980's.



ADVANTAGES

AST simulators are owner-oriented, with many benefits to the user. These include:

—Improved performance

—Fewer components

—Reduced spares requirements

—Capability for 100% simulation

—Advanced instructional capabilities

—Higher fidelity

—Standardized hardware elements

—Improved software

—Automatic monitor and fault detection

—Reduced mean time to repair

—Increased reliability and availability

—Easier maintenance

—Improved visual system integration

ADVANCED SIMULATION

Advanced simulation is well within the capability of *AST* simulators.

A major breakthrough was achieved when B-727-100 simulators were approved by the FAA for landing maneuver and recency of experience training. As a result, the technical requirements and guidelines for approvals as set forth in the new FAA-Phase 1 advance simulation requirements have been achieved.

The landing approval followed a year and a half of extensive flight testing, data reduction and programming by Link and airline personnel.

The stage is now set for total simulation. *AST* simulators have been designed as the hardware vehicle of today for advanced software to achieve advanced simulation tomorrow.


AST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ADVANCED INSTRUCTOR STATION

The effectiveness of the new simulator technology developed by Link is evident in the advanced instructor station, which is designed to facilitate today's highly complex dynamic flight simulator training sessions.

The station incorporates new equipment developed by Link to provide maximum simplicity of operation. A dual CRT presentation enables instructors to monitor student performance and progress with utmost ease.

The instructor station area is within the simulated flight compartment behind the captain's position. It has facilities for a pilot instructor, flight engineer instructor and an observer.

The high-quality CRT system provides clear alphanumeric and graphic displays of information required by instructors at various points of training exercises.

Both the pilot instructor and the flight engineer instructor are provided with separate yet identical CRT display units and control panels. Thanks to Link's human engineering design, each instructor can remain close to his trainee while, without changing position, easily operating his controls. The control panels and the CRT displays are the only devices required by instructors to effectively control and monitor the training problem.

The simulator/display control panels are connected to the computer through the new *AST** real-time interface equipment, enhancing reliability and maintainability of the instructor control system. The fact that the two control panels are identical allows them to be used interchangeably in the event of a malfunction in one of the panels or its interface equipment.

Furthermore, the control panels and their interface equipment are completely independent of the CRT display systems—i.e., they will be connected only via the software in the digital computer. Thus control of a training exercise is still possible in the event of a failure of either or both CRT displays.

In addition, an optional instructor's remote control unit can be supplied with the simulator to give an instructor the capability of controlling training exercises while seated in one of the flight crew positions.

The controls and status indicators on the simulator control panel are functionally grouped and color-coded to facilitate rapid identification and access. The compact yet readily accessible panel is further reflection of Link's unique human engineering design, which affords maximum instructor control capability while requiring a minimum of control operation.

The two CRT displays are the primary devices used by instructors to monitor the training mission.

The programmable nature of the CRT displays permits changes in the type or arrangement of information presented, or expansion of the training capabilities (such as additional malfunctions), without any expensive electrical and mechanical hardware changes or additions to the instructor station. Typically as many as 70 preprogrammed display pages (alphanumeric and/or graphic) are provided.

In summary, the advanced instructor station improves and reduces training time because:

—The flexibility of the CRT display system allows easy update of the system configuration. New training requirements can be met without additional expensive hardware changes.

—Simplicity of operation reduces instructor familiarization time.

—Instructors are supplied with more information more quickly, with a minimum of attention-diverting effort.

—Training is more fully devoted to student needs and can be adapted to any operating and/or training environment.

Latest CRT developments are incorporated in the advanced instructor station which displays constantly updated information either graphically, as the airport approach patterns in various scales (above), or alpha-numerically in full color with highlights (above right).

MOTION SYSTEM

AST simulator motion is provided by a six-degree-of-freedom synergistic system of an entirely new design employing advanced concepts to achieve marked improvements in performance.

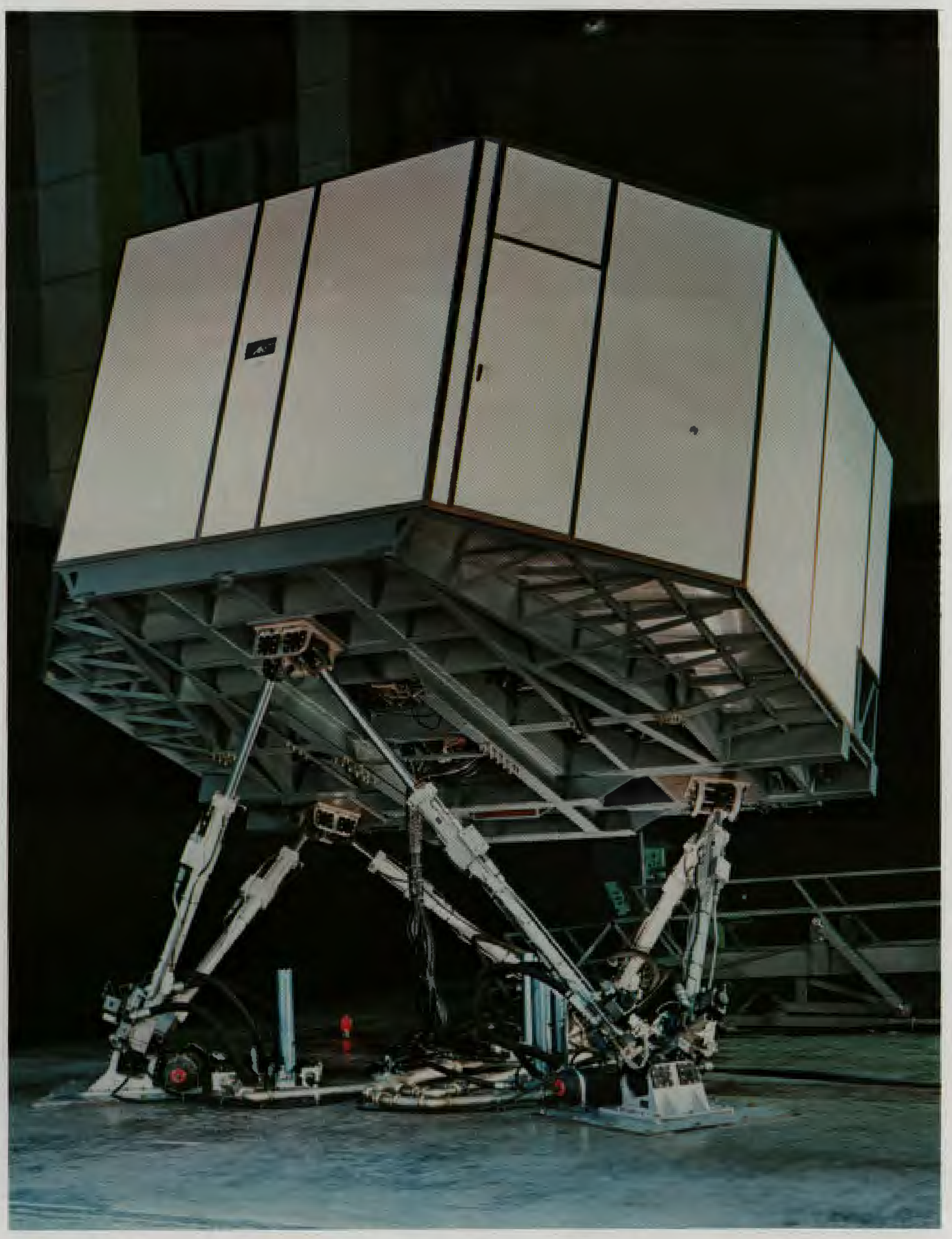
The most significant technical breakthrough was development of the high-performance actuator assembly. A unique hydrostatic bearing design solves the actuator friction problem, which occasionally produced an undesirable "bump" in motion cues of conventional systems.

A new ultrasonic linear displacement transducer eliminates all mechanical coupling between the actuator and sensor, resulting in an extremely clean (noise-free) position feedback signal.

Also unique to the actuator assembly is an "in-line" cushion design employing piccolo orifices which assures smooth system erection. This foolproof energy absorbing technique limits G forces to acceptable levels.

The complexity which characterizes motion systems of conventional simulators has been significantly reduced. More than two-thirds of the plumbing has been eliminated. Platform, joint and electronic assemblies have been simplified, reducing the chance of oil leaks, making the equipment more accessible and facilitating maintenance.

This not only improves appearance but also provides better hydraulic performance, fewer connections and parts, and greater reliability.



High-flow-capacity servo control valves virtually eliminate hydraulic fluid noise at the motion base. The hydraulic power supply has a separate pump with a parallel heat exchanger, allowing the system to operate at lower oil temperatures.

Reductions in system pressure and pipe connections minimize the possibility of oil leakage. Lower system pressure allows the use of vane pumps instead of variable-displacement piston-type pumps, significantly reducing noise levels in the pump room. This simplifies pump room design and lowers users' facility costs.

The *AST** motion system geometry is optimized to place the platform closer to the floor, expanding the amount of excursion available for motion cues. Combined with "in line" cushions and other improvements, the new geometry enhances the safety of the system without compromising performance.

The *AST** motion electronics is packaged in a single-bay cabinet. The electronics communicates directly with the *AST** interconnection bus and requires only four PC board types.

INTERCONNECTION SYSTEM

The interconnection system encompasses all electronics and wiring between the digital computer and the simulator's flight compartment.

A conventional simulator has a maze of cables, interface cabinets and wired backplanes. These connect conversion and signal conditioning electronics that

are physically diversified and normally remote from the cockpit input sources and final drive loads. This results in a mass of related technical documentation; it involves multiple assemblies that are difficult to trouble-shoot.

The *AST* simulator solves these problems by employing a digital transmission bus concept. All communications are performed with serialized digital data. This allows all of the system functions associated with driving or receiving information from the cockpit systems to be constrained to single assemblies (system cards). The extensive wiring and cabling traditionally employed thus can be eliminated.

A single master controller interfaces with the digital computer and communicates with up to 19 subcontrollers on a common transmission bus. Each subcontroller in turn passes along signal data to one of 16 system cards which it controls.

This electronics packaging approach is so compact that it uses only 20% of the space previously required.

In addition to providing better performance and reliability, the digital bus concept makes possible automatic test features which significantly reduce equipment maintenance time and cost.

AUTOMATIC TEST FEATURES

An automatic continuous closed-loop testing system (ACCTS) provides fault isolation capability throughout the system.

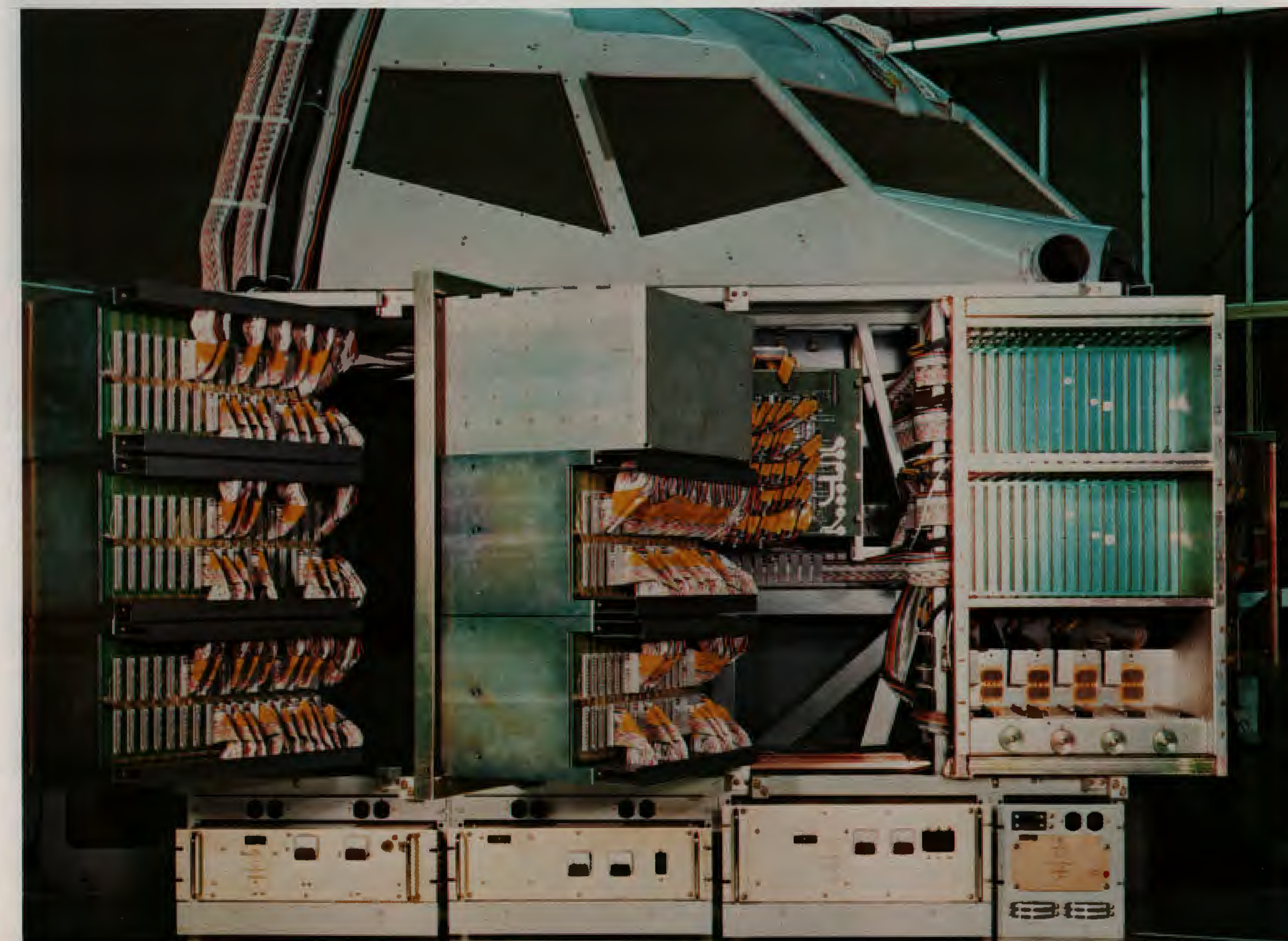
Many of these tests are performed automatically, without computer intervention, while the simulator is being used for training. The real-time monitor test, for example, checks every single input and output conversion device at least once every five seconds while training is in progress. Errors are reported on an automatic printout.

This system traces each fault to a single system card and, for subsequent off-line repair, will isolate the failure on the card to within three chips in most instances.

Analog test conversion hardware is calibrated before conducting such diagnostics, thus providing a readout so accurate that it can be used for calibration adjustments.

The master controller is equipped with a local digital maintenance control and readout panel to provide full "look and enter" capability. The panel also provides a remote decimal readout capability which allows connection to the system bus, thus furnishing remote computer memory readout.

For off-line repair of the system cards, a single card file and subcontroller card enable troubleshooting in the maintenance area, utilizing data received on the simulator's digital transmission bus. This is an extremely flexible and inexpensive card test tool when contrasted with independently driven test consoles of the past.



Linkage and conversion electronics are close to the cockpit equipment they serve—easily accessible in swing-out bins for cost-effective maintenance.

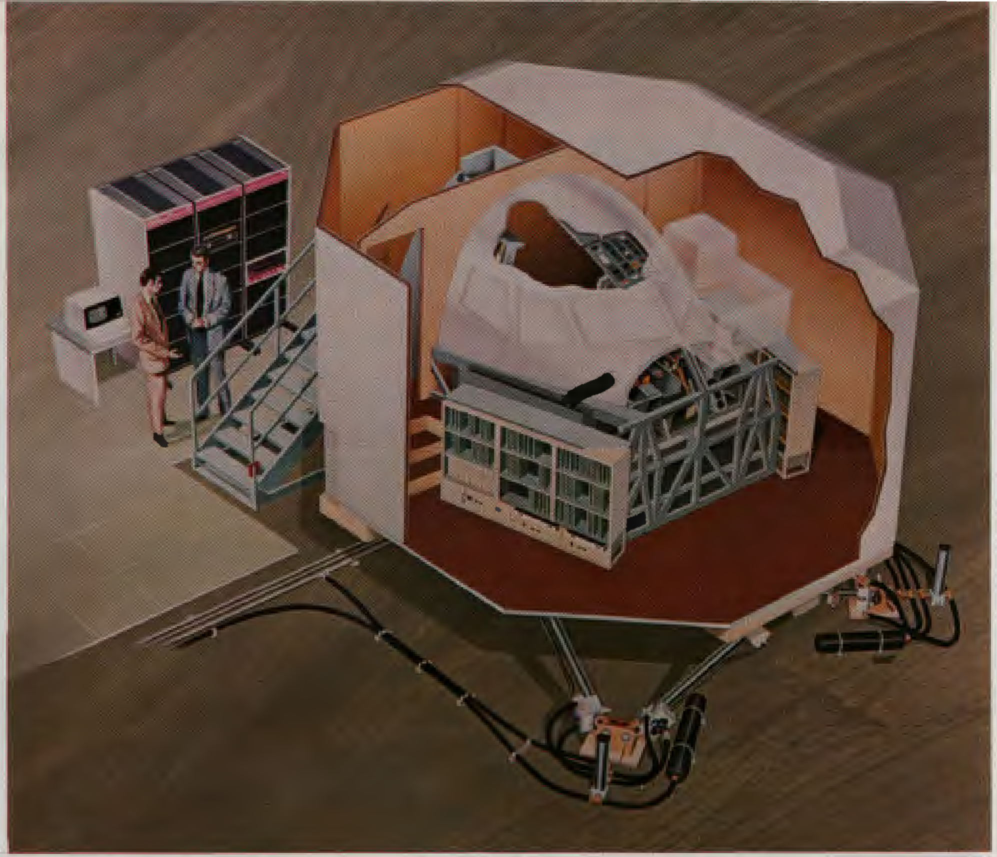
CONTROL LOADING SYSTEM

The *AST** control loading system is designed to improve system response and force characteristics.

It employs a hybrid (digital/analog) electronics concept. This insures accuracy, resolution and smoothness of integration while allowing certain control loading characteristics to be programmed digitally.

The control loading unit minimizes mechanical play by providing direct shaft linear coupling of the actuator to its force input and to the transducers. A low-friction actuator ensures high system performance and overall system response.

As a safety feature the assembly includes electromechanical bypassing and sensing circuitry to limit stick forces.



AURAL CUE SYSTEM

The *AST** aural cue system provides full sound representation, with realistic frequency, amplitude and directional characteristics.

Five channels are employed, with speakers placed some distance from the crew to assure undistorted dispersion. Sounds, including percussive and low frequency ones, are reproduced with remarkable clarity.

A wide variety of sounds are provided, ranging from ground power start, taxi rumble, landing gear door and flap extension to turbine whine, hydraulic pumps, compressor fan and aerodynamic hiss. Other sounds include strut compression, exhaust, cabin ventilation and inverter.

The aural cue system cards contain all electronics associated with sound simulation, including input/output conversion and closed loop testing. Only seven PC cards are required instead of 30 in conventional systems—another example of the economy of space inherent in the *AST* simulator design.

A single bus replaces the complex array of cables and wires of previous designs.

The system is software programmable so if better sound data becomes available it can be incorporated readily into the simulator.

ADVANCED PACKAGING CONCEPT

An entirely new approach to simulator packaging is one of the most distinctive and practical features of the *AST* simulator.

Link has departed from the conventional practice of building the simulator exterior to resemble the simulated aircraft. Instead, a functional design is used which offers significant operating and maintenance advantages.

After analyzing various transport aircraft flight compartments, Link devised a layout which permits the location of electronics as close as possible to the simulator hardware they service. Nearly all *AST** components are self-contained within an octagonal enclosure about the cockpit, mounted on a motion system. The space inside the enclosure around the cockpit is used for the electronic components.

This arrangement reduces by 80% the space normally required for conventional simulator interface.

The performance of the electronics is substantially improved by the elimination of long analog cables and interfaces that mix AC and high current signals with critical low current signals. In *AST* simulators, the separation of critical signals is maintained up to the cockpit assemblies they service.

The electronics is mounted in hinged gate assemblies, making it readily accessible for servicing. Cockpit strut construction permits maintenance to be accomplished from outside as well as inside, with easy access to instrument panels and cable runs.

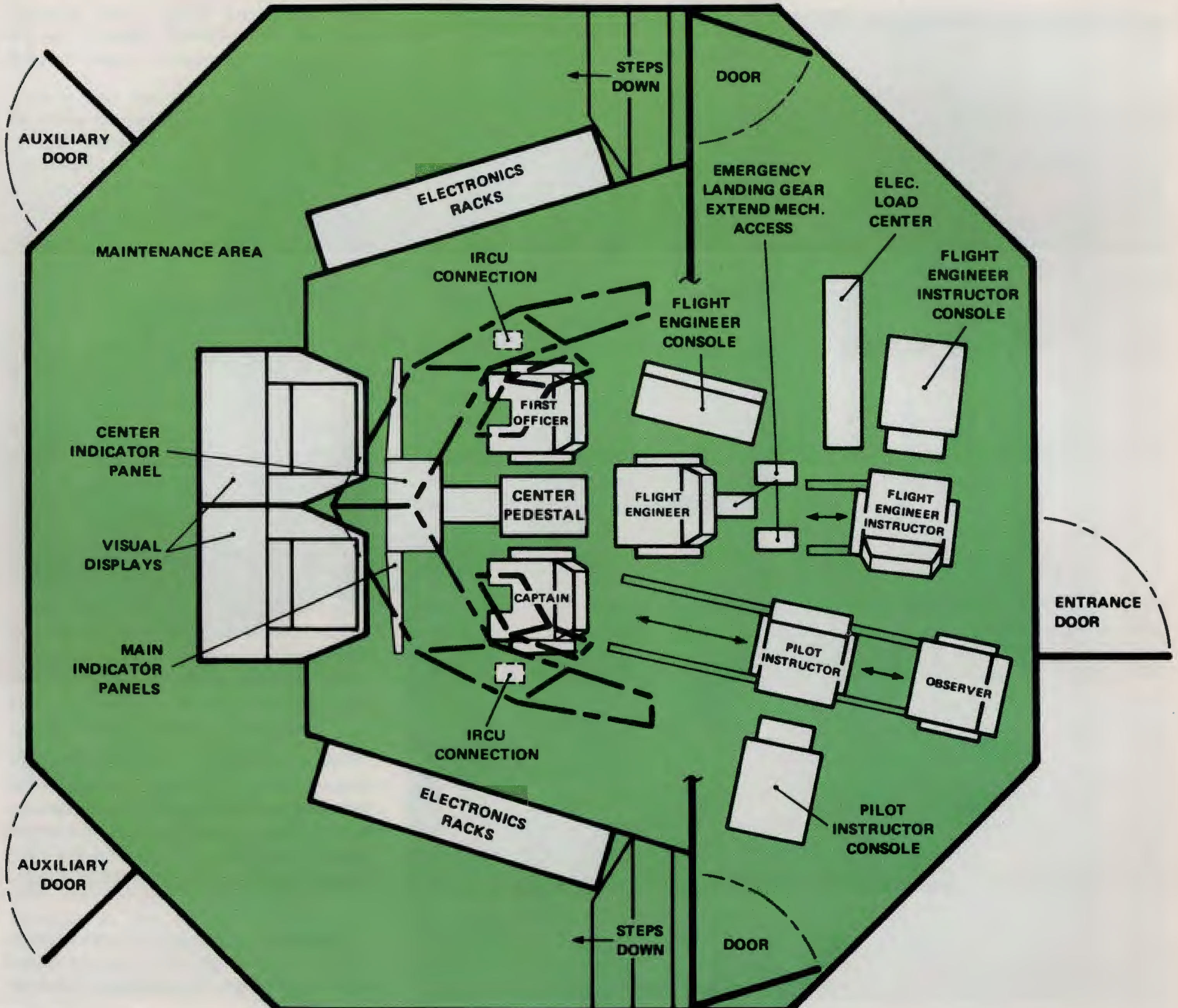
Since most of the simulator's components are inside the enclosure, considerably less floor space is required in the simulator facility.

The cockpit interior remains a replica of the flight deck of the aircraft simulated. In fact, since simulation electronics is not packaged in the cockpit interior, the area is less cluttered and resembles the aircraft even more.

The additional space provided by this configuration enables the instructor to function in comfort and with maximum efficiency. He can look over trainees' shoulders and simultaneously operate the instructor controls without shifting position.

Placing most *AST* components in a closed environment facilitates use of visual, air conditioning and fire suppression systems.

Even ancillary equipment, such as lighting, staircases and chairs, have been redesigned to increase the overall effectiveness of the *AST* simulator.



COMPUTER SYSTEM

The computer system utilized in *AST* simulators is the SEL 32/77, the latest model produced by Systems Engineering Laboratories (SEL).

The SEL 32/77 is configured by Link to provide the most powerful complex for simulator applications. This computational power is essential for increasing dynamic response, accuracy and fidelity required for modeling the aircraft and its environment to meet the requirements of the 100% simulation program.

Unprecedented computational power, ranging from 1.2 million operations per second with 1.2 megabytes of memory for 727 type aircraft to an excess of 2.3 million operations per second and 1.53 megabytes of memory for 757/767 type aircraft, is provided.

Yet, there is still architectural room to grow. . . . to double the computational power and expand the memory system to 16 megabytes.

The SEL 32/77, with exceptional flexibility and performance, is ideally suited to the simulation task. Its features include:

—Memory addressing of 16 megabytes
—Full shared memory capability
—Multi-processor capability
—26.67 megabyte/second BUS band width
—Hardware floating point, scientific accelerators, internal processing units.
—Fast memory access and instruction excursion times
—Very fast I/O service and software task switching
—Large flexible instruction set
—Extensive and powerful operating and support software
—Wide range of peripheral services

An extensive diagnostic package and advanced features such as memory error correction code (ECC) provide for easy maintenance which complements the computer's proven high reliability.

The operating system provides high efficiency real time processing, concurrent multi-terminal integrated processing, and flexible concurrent batch processing which is ideally suited for real time simulation. Systems programming and FORTRAN 77+ (meets ANSI × 3.9-1978 and MILSTD 1753) greatly facilitate software maintenance and simulator updates and this software is fully augmented by the most extensive simulator diagnostic package available in the industry.

But most important of all are the sophisticated math models and software which are critical in advancing aircraft simulation. In this area, Link's unsurpassed experience is setting new standards for the industry.

VISUAL SYSTEM INTEGRATION

Link will assume full responsibility for the integration of any computer-generated image visual system on the market. Furthermore, it guarantees performance.

Typical scenes furnished by two types of Visulink *visual systems, DIG above and DNVS below.*

This guarantee is buttressed by wide-ranging experience. Link has sold and integrated nearly two score of its *Visulink** visual systems: Point/Scan Night Visual Systems (NVS), Dusk Occulting Night Visual Systems (DNVS) and Full/Scan Digital Image Generators (DIG).

Link also has integrated a number of other makes of visual systems. Customers therefore can be confident that, regardless of the type of visual system chosen, *AST* simulators will operate with optimum effectiveness and realism.

SUPPORT

Quality is the keynote of *AST* simulators—quality based on half a century's experience in flight simulation.

This unrivaled experience is backed up by a dedicated field service organization second to none. Customers are thus assured of around-the-clock around-the-world support.

Augmenting this support is an exclusive terminal diagnostic service called *Satellink**. This enables a customer's *AST* computer to be connected by regular telephone lines to a CRT at Link headquarters where engineers can diagnose problems and devise speedy solutions.

Link support is broad-based, including not only trouble-shooting but also updating. While *AST* simulators are being designed and built their specifications are changed if necessary to reflect changes in the aircraft being simulated. This is especially valuable in cases where new performance data becomes available to help achieve 100% simulation.

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